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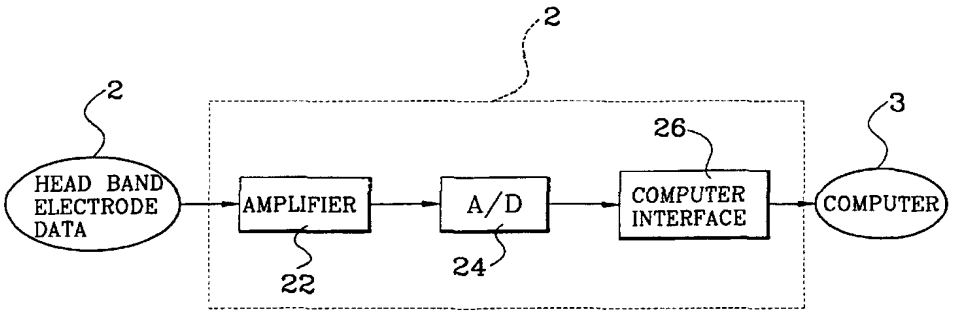
(54) Title: GAME DEVICE USING BRAIN WAVES AND GAMING METHOD THEREFOR




(57) Abstract: A game device and method using brain waves are provided. The game device and method can control a game picture displayed on a monitor screen using the measured brain waves. The game device includes a unit for measuring and inputting brain waves, and a computer for comparing, analyzing and processing the measured brain waves with respect to reference brain waves and driving and outputting a stored game program in accordance with a processed result. The brain wave measurement and input unit includes a head band which is worn on the head of the user and where electrodes for detecting brain waves are attached, an amplifier for amplifying the brain waves measured in the head band, and a computer interface for converting the amplified brain wave signals into computer-readable signals. The reference brain waves are obtained by following a change in statistical parameters of an alpha wave and a beta wave extracted from the measured brain waves, or are input from a brain wave database. A current brain wave of the user is compared with the reference brain wave, to feed a visual and aural signal appropriate for the user back to the user. Thus, a standard of the brain wave having signal matching each user can be set to adjust his or her own brain waves having an appropriate difficulty of the game. Further, the left and and right brain waves can be simultaneously used to give an effect of correcting asymmetry of the left and right brains.

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# GAME DEVICE USING BRAIN WAVES AND GAMING METHOD THEREFOR

## Technical Field

The present invention relates to a game device using brain waves and a gaming method therefor, and more particularly, to a game device which measures the change in brain waves varying according to the consciousness and will of a user while reflecting individually intrinsic features of brain waves on a game and alters the situation of the game.

## Background Art

An electrical potential difference of several tens of micro volts at a frequencyless than 30Hz and measured from the skin of the human head is a physical value reflecting the state of consciousness and highly valuable in the fields of science and technology. As one technological application, a device control technology using only thinking of a human being is being studied so that a device recognizes the will of the human being directly. When a human being is in a psychologically stable state or closes his or her eyes, alpha waves of 8-13Hz are dominant. In the stable state or when there are no thoughts, beta waves of 13-30Hz decrease.

In the prior art, a mind switch was disclosed, in which the change in alpha waves due to opening and closing of the eyes of a human being is used, so that only thinking operates a device, turns on or off an electric bulb, or manipulates a toy simply. Also, the fact that the intensity of the brain waves decrease in the stable state is used, so that a racing match game apparatus uses only a thinking as its on-and-off control signal. If a human being closes his or her eyes to rest, a positiveness/negativeness (on/off) can be easily recognized since the change in brain waves fluctuates greatly. However, even when a human being does not close his or her eyes, the recognition ratio for a one-bit mental discrimination such as the on/off discrimination is very high, and the recognition ratio further increases through practice. Also, an eye tracker was proposed in which a cursor on a computer monitor can be moved

in accordance with what a user looks at by tracking the movement of the user's eye balls. U.S. Patent No. 5,638,825 was issued as an example of the prior art relevant to the above cursor movement.

Since the above existing control methods using brain waves adopt brain wave recognition irrespective of the difference in brain waves of each person, an analytical error can occur due to the individual difference in brain waves of the human being. Also, since each individual brain wave is not compared with a brain wave database comprised of statistical values, a frequency domain which can be easily controlled by each person, or an individual concentration capability cannot be effectively used. Further, there exists no technology for changing the situation of a game picture by measuring brain waves.

Disclosure of the Invention

To solve the above problems, it is an objective of the present invention to provide a game device and method using brain waves which vary according to the change in a user's will to enjoy a game, in which reference brain waves reflecting individual features of brain waves of each user on a real-time basis are used.

It is another objective of the present invention to provide a game device and method using reference brain waves made up by considering the features of the brain waves of each user, in which brain waves of the user is preliminarily measured, and the preliminary brain wave measurements are compared with a brain wave database.

To achieve the objective, there is provided a game device comprising: means for measuring and inputting brain waves; and a computer for comparing, analyzing and processing the measured brain waves with respect to reference brain waves and driving and outputting a stored game program in accordance with a processed result.

Preferably, the brain wave measuring and inputting means comprises: a head band which is worn on the head of the user and where electrodes for detecting brain waves are attached; an amplifier for amplifying the brain waves measured in the head band; and a computer interface for converting the

amplified brain wave signals into computer-readable signals.

Preferably, the computer can change the screen of the game according to the comparison result of the frequency analysis result of the user's brain waves with the reference brain waves. Also, the reference brain waves are determined by analyzing the user's brain waves on a real-time basis, or are input from a brain wave database. The measured brain waves are compared with the reference brain waves, to find and feedback a brain wave control signal appropriate for the user.

According to another aspect of the present invention, there is provided a gaming method for a game device comprising the steps of: measuring and inputting brain waves; and comparing, analyzing and processing the measured brain waves with respect to reference brain waves and driving and outputting a stored game program in accordance with a processed result, by using a computer.

Preferably, the computer compares the frequency analysis result of the brain wave signal with the reference brain waves, to alter the screens of the game according to the user's brain waves. Also, the reference brain waves are calculated on a real-time basis according to the brain waves in use of the user and the measured brain waves are compared with the reference brain waves, to find and feedback a brain wave control signal appropriate for the user.

Preferably, the computer compares the frequency analysis result of the brain wave signal with the reference brain waves, to alter the screens of the game according to the user's brain waves. Also, the reference brain waves are input from a brain waves database and the measured brain waves are compared with the reference brain waves, to find and feedback a brain wave control signal appropriate for the user.

## Brief Description of the Drawings

The above objectives and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the attached drawings in which:

FIG. 1 schematically shows a game device using brain waves according to the present invention;

FIG. 2 is a block diagram schematically showing the circuitry portion of FIG. 1;

FIG. 3 is a flowchart view for explaining a first embodiment of a method of operating a game program of FIG. 1;

FIG. 4 is a flowchart for explaining a second embodiment of a method of operating a game program of FIG. 1; and

FIG. 5 shows an example of a game picture applied to the present invention.

Best mode for carrying out the Invention

Hereinafter, the structure and operation of a game device using a brain waves pattern according to preferred embodiments of the present invention will be described with reference to the accompanying drawings.

A game device, as shown in FIG. 1, according to the present invention utilizes brain waves measured by a brain waves measuring system. In FIG. 1, a head band 1 looking like a hair band contacts the skin of the head of a user, to simply measure the brain waves. The brain waves are measured by electrodes (not shown) within the head band 1. The minute analog voltage signals of the measured brain waves have an electric potential difference of several micro volts through several tens of micro volts, respectively, at a frequency of less than 30Hz. The analog voltage signal is amplified and converted into a computer-readable digital signal in a converter 2, to then be supplied to a computer 3. The computer 3 processes the input brain waves signal and displays it on a display 4.

The circuit of the converter 2, as shown in FIG. 2, includes an amplifier 22 which receives a head band electrode signal of several micro volts and amplifies it fifty thousand times, an analog to digital converter 24 for converting the amplified analog signal into a digital signal, and a computer interface for converting the digital signal from the analog to digital converter 24 into a signal being input to a computer serial port.

The computer 3 analyzes the brain wave signal which has been measured and input to the computer 3 and extracts several parameters from it. In the present invention, amplitudes, average values and standard deviations of an alpha wave and a beta wave among the brain waves measured at the left and right frontal lobes of the brain, and a ratio of the alpha and beta waves are used as parameters. The analysis method for extracting the measuring positions of the brain waves, the frequency and the parameters are varied appropriately according to the purpose and the type of game. In order for a gamer to become more advantageous in the game as the stability of the user becomes higher, the ratio of the alpha waves and beta waves is chiefly used as a parameter. The parameters of the brain waves used for producing a game control command language are called control variables. In order to discriminate the state or will of the user by using the brain wave control variables, a reference value of each variable is required. For example, if a variable X becomes larger than a reference value $X_0$, an object on the computer monitor rises up, otherwise the object falls down. Here, there are cases of obtaining it in real-time and by using a database as the method of determining the reference value $X_0$.

In the case that the reference value is determined in real-time, the brain waves need not be measured in advance and the brain wave signal measured in real-time are statistically analyzed, for example, frequency-analyzed to determine a reference value. For example, an average value of an alpha wave ratio from a game start time to a current time is determined as a reference value. If an alpha wave ratio higher than the reference value is measured, it is determined that the user is in a stable state.

In the case that a database is used, the brain waves of the user are measured in advance and then a reference value appropriate for the brain waves of the user is input from the database. When the user starts to enjoy the game, he or she registers his or her own brain waves through measurement of the brain waves. After his or her own brain waves have been registered, the registered values are used. The database includes reference values of the variables appropriate for the individual features of the brain

waves according to the statistical analysis result with respect to the brain waves of several persons.

A command word produced using the above reference value can be expressed by the following Equation 1.

$$\Delta S = A(1 - \frac{X}{X_0}) \quad \ldots(1)$$

Here, $\Delta S$ is a function for determining production of a command word such as the position of an object on a computer, the amount of change in the velocity of the object, the degree of movements of a moving image and the increase in scores. X is a component used as a variable among the brain waves, $X_0$ is a reference value and A is a coefficient determining the proceeding velocity.

In the case that two or more variables are used, a command word is produced by using a value obtained by adding each value obtained by multiplying $\Delta S_i$ according to each variable Xi by a weight value Wi as in the following Equation 2.

$$\Delta S = \sum_i W_i \Delta S_i \quad \ldots(2)$$

FIG. 3 is a flowchart view showing a case in which the brain waves of a user are measured in real-time and a statistical average value for a predetermined period of time is determined as a reference brain wave value, among operation methods of a game device using the brain waves according to the present invention. This will be described below with reference to FIGs. 1 through 3.

If a user wears a head band 1 on the head and turns on a game device according to the present invention, a measured brain wave signal is input to a computer 3 (step 30). The computer 3 statistically analyzes the brain wave signal measured in real-time for a predetermined time without having a need to measure the brain waves in advance, and determines a reference value. For example, an average value of an alpha wave ratio from the game start

time to a current time is determined as a reference value. If an alpha wave ratio higher than the reference value is measured, it is determined that the user is in a stable state. If the brain wave value of the user is obtained in step 32, the computer 3 proceeds to a game mode and displays an initial game picture (step 40). Then, the computer 3 measures the current brain waves of the user (step 42). Then, the computer 3 compares the determined reference brain waves with the current measured brain waves, and determines the direction and velocity of animation, in order to control a game screen (step 44). Then, the computer 3 controls a picture animation to be displayed according to the determined game picture control amount (step 46). Then, the user determines whether he or she will continue or complete the game (step 48). If the user completes the game, the user information processed up to now is not stored to then complete the game. If the user continues the game, the program proceeds to step 48, in which the current brain waves are measured to calculate a function and then control a picture animation in step 46 through a game control step 44.

Meanwhile, another embodiment of the present invention will be described with reference to FIG. 4.

FIG. 4 is a flowchart showing a case in which a database is used, among operation methods of a game device using the brain waves according to the present invention. This will be described below with reference to FIGs. 1, 2 and 4.

If a user wears a head band 1 on the head and turns on a game device according to the present invention, a measured brain wave signal is input to a computer 3 (step 30). The computer 3 searches whether an input brain wave signal of a user is registered in a brain wave database stored in a memory or a hard disc therein (step 32). If it is judged that a user's brain wave pattern is not registered in step 34, brain waves are measured in a brain wave measurement mode (step 36). Then a reference brain wave value is obtained using the measured brain waves or the user registration information (step 38). If a reference brain wave value is obtained in step 38, the computer 3 proceeds to a game mode to then control an initial game screen to be

displayed (step 40). Then, the computer 3 measures the current brain waves of the user (step 42). Then, the computer 3 compares the determined reference brain waves with the current measured brain waves, and determines the direction and velocity of animation, in order to control a game screen (step 44). Then, the computer 3 controls a picture animation to be displayed according to the determined game picture control amount (step 46). Then, the user determines whether he or she will continue or complete the game (step 48). If the user completes the game, the user information processed up to now is stored to then complete the game (step 50). If the user continues the game, the program proceeds to step 42, in which the current brain waves are measured to calculate a function and then control a picture animation in step 46 through a game control step 44.

As an example of a picture which is applied to the game device according to the present invention, a picture of a spoon is illustrated as shown in FIG. 5. If a brain wave of 4 through 7Hz which is good for the user to perform supernatural acts, is dominant, the game can proceed so that the spoon is bent. As different examples of such games, an aerial floating picture of a human body or a running human body picture contracting or compressing space by magic is displayed as the picture of a game. Besides, the present invention can be applied to a complicated animation game such as a motion image game operating with cursor keys (→, ↑, ↓, ←), a control key (CTRL), an alt-key (ALT) and a space bar to move a cursor. Also, the game device according to the present invention proceeds so that the brain waves of the user become stable while enjoying the game. As described above, the level of the amplitude can be adjusted by the stable brain waves and the criteria for stability. In addition, if the brain waves become stable, the image on the monitor screen is changed into a picture having a positive image or into a situation where the scores increases. Accordingly, the user maintains the stable status and obtains a feedback effect so that the stability grows deeper.

As described above, the game device using the brain wave pattern according to the present invention has considered an increase and decrease in alpha waves, an increase and decrease in beta waves, an increase and

decrease in the ratio between alpha waves and beta waves, and the frequency region and amplitude level of the brain waves. The present invention can also perform a game control of a desired game device, using information contained in theta waves and delta waves being other kinds of brain waves and an increase and decrease in the theta waves and delta waves, or using an average value of each channel or the entire channel of the kind of each brain wave, where not only the frequency region and the amplitude level but also portions of the brain wave measurement on the skin of the head are various channels.

As described above, the game device and method using the brain waves according to the present invention analyzes statistics of the brain waves of a user in real-time or preliminarily measures the brain waves of the user, to then compare the measured brain waves with a brain wave database. Accordingly, the present invention determines the degree of concentration and an amplitude by which each user can easily control. Also, in the case of a computer game using the brain waves, the difficulty of the game is adjusted according to features of the brain waves of each user, to enable the user to enjoy the game. The present invention measures the brain waves of the left and right frontal lobes and alters the picture on the computer screen into a more positive and brighter image according to the measured brain waves or controls the game into a situation advantageous for the user to obtain higher scores, which gives an effect of being more stable mentally while enjoying the game.

The present invention is not limited to the above-described embodiment and various modifications and changes may be effected by one skilled in the art within the scope of the present invention.

Industrial Applicability

The game device and gaming method according to the present invention can be applied to a computer game device using a computer software program, or a meditation induction apparatus, a study efficiency enhancement apparatus, and so on.

What is claimed is:

1. A game device comprising:

means for measuring and inputting brain waves; and

a computer for comparing, analyzing and processing the measured brain waves with respect to reference brain waves and driving and outputting a stored game program in accordance with the processed result.

2. The game device of claim 1, wherein said brain wave measuring and inputting means comprises:

a head band which is worn on the head of the user and where electrodes for detecting brain waves are attached;

an amplifier for amplifying the brain waves measured in the head band; and

a computer interface for converting the amplified brain wave signals into computer-readable signals.

3. The game device of claim 1 or 2, wherein said brain waves include amplitudes of the alpha wave and beta wave, the relative ratio of the alpha wave with respective to the beta wave, and the standard deviation of distribution of the alpha wave and beta wave.

4. The game device of claim 1 or 2, wherein said computer can change the screen of the game according to the comparison result of the frequency analysis result of the user's brain waves with the reference brain waves, the reference brain waves are determined by analyzing the user's brain waves on a real-time basis, and the measured brain waves are compared with the reference brain waves, to find and feedback a brain wave control signal appropriate for the user.

5. The game device of claim 1 or 2, wherein said computer can change the screen of the game according to the comparison result of the frequency analysis result of the user's brain waves with the reference brain

waves, the reference brain waves are input from the brain waves database, and the measured brain waves are compared with the reference brain waves, to find and feedback a brain wave control signal appropriate for the user.

6. The game device of claim 1 or 2, wherein brain wave signals of the left and right frontal lobes are used in the analysis of said brain wave signal.

7. A gaming method for a game device comprising the steps of:

measuring and inputting brain waves; and

comparing, analyzing and processing the measured brain waves with respect to reference brain waves and driving and outputting a stored game program in accordance with a processed result, by using a computer.

8. The gaming method of claim 7, wherein said computer compares the frequency analysis result of the brain wave signal with the reference brain waves, to alter the pictures of the game according to the user's brain waves, the reference brain waves are calculated on a real-time basis according to the brain waves in use of the user and the measured brain waves are compared with the reference brain waves, to find and feedback a brain wave control signal appropriate for the user.

9. The gaming method of claim 7, wherein said computer compares the frequency analysis result of the brain wave signal with the reference brain waves, to alter the pictures of the game according to the user's brain waves, the reference brain waves are input from a brain waves database and the measured brain waves are compared with the reference brain waves, to find and feedback a brain wave control signal appropriate for the user.

10. The gaming method of claim 8 or 9, wherein brain wave signals of the left and right frontal lobes are used in the analysis of said brain wave signal.

FIG.1

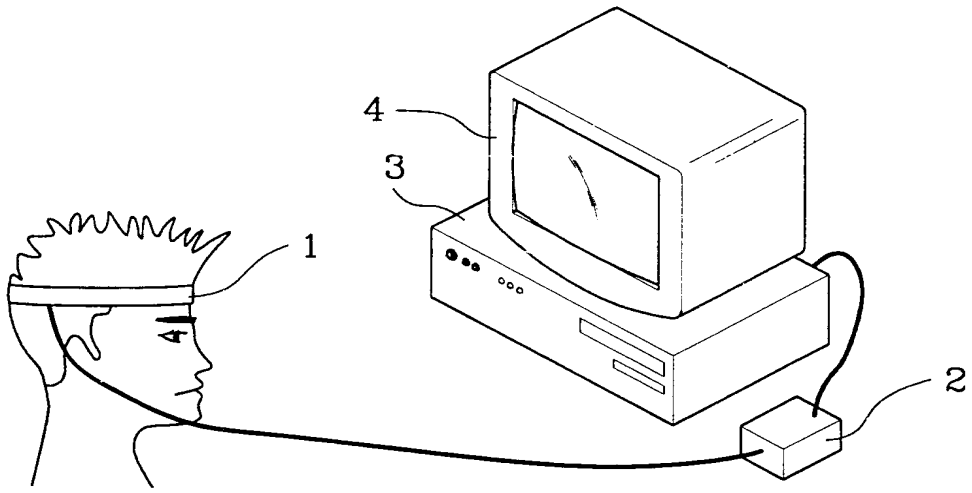

4
3
1
2

FIG.2

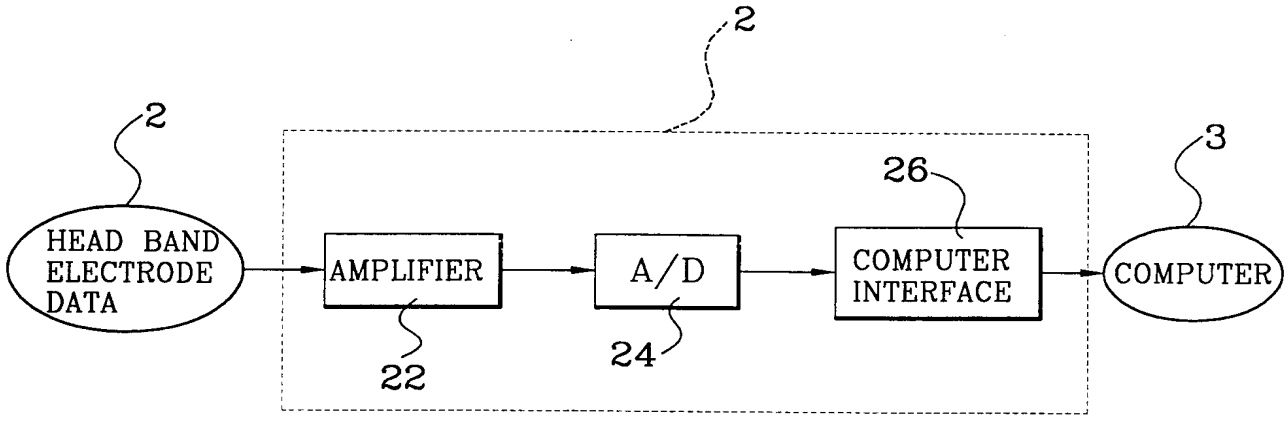
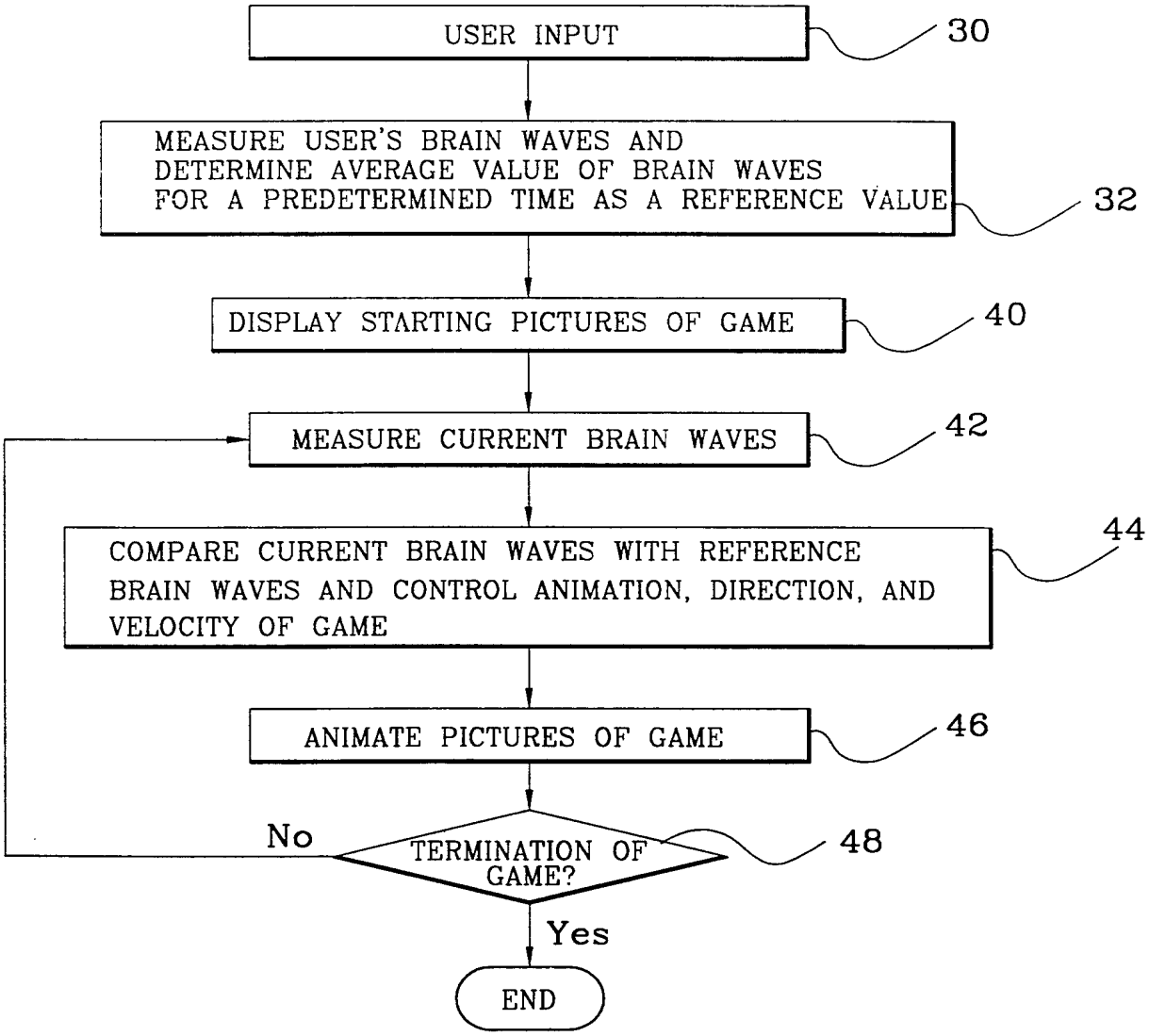

2
2
HEAD BAND ELECTRODE DATA
AMPLIFIER
A/D
COMPUTER INTERFACE
COMPUTER
3
26
22
24

FIG.3


USER INPUT
30
MEASURE USER'S BRAIN WAVES AND DETERMINE AVERAGE VALUE OF BRAIN WAVES FOR A PREDETERMINED TIME AS A REFERENCE VALUE
32
DISPLAY STARTING PICTURES OF GAME
40
MEASURE CURRENT BRAIN WAVES
42
COMPARE CURRENT BRAIN WAVES WITH REFERENCE BRAIN WAVES AND CONTROL ANIMATION, DIRECTION, AND VELOCITY OF GAME
44
ANIMATE PICTURES OF GAME
46
No
TERMINATION OF GAME?
48
Yes
END

3/4

FIG.4

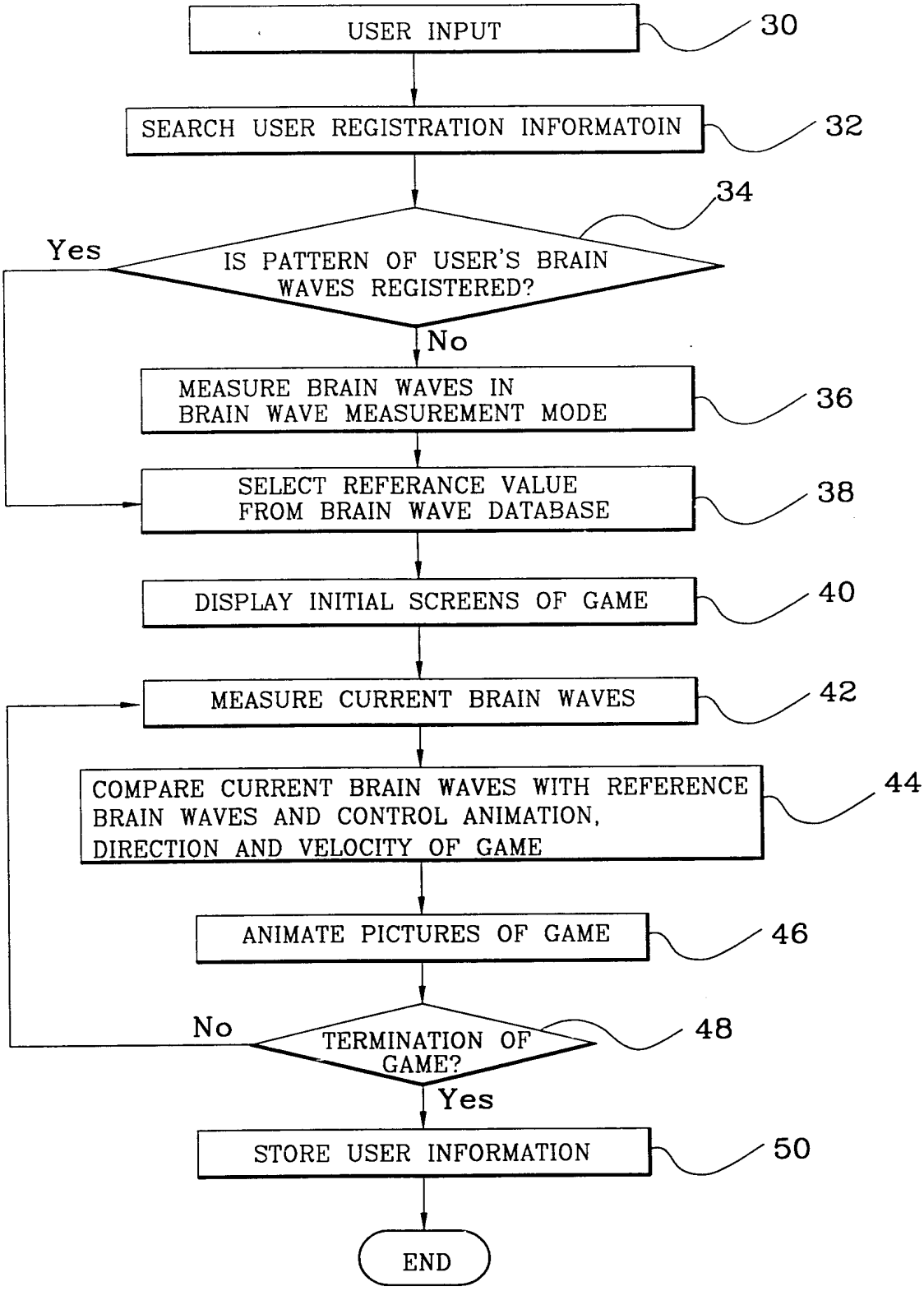
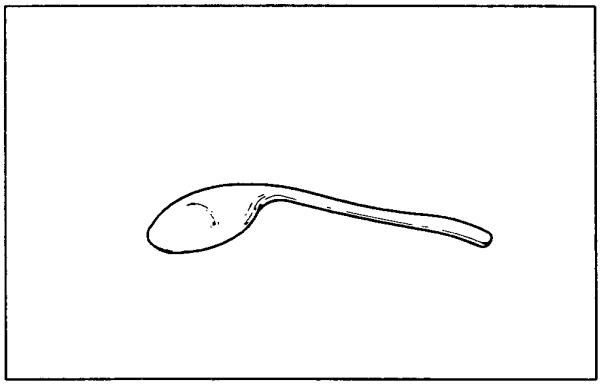

USER INPUT
30
SEARCH USER REGISTRATION INFORMATOIN
32
34
Yes
IS PATTERN OF USER'S BRAIN WAVES REGISTERED?
No
MEASURE BRAIN WAVES IN BRAIN WAVE MEASUREMENT MODE
36
SELECT REFERANCE VALUE FROM BRAIN WAVE DATABASE
38
DISPLAY INITIAL SCREENS OF GAME
40
MEASURE CURRENT BRAIN WAVES
42
COMPARE CURRENT BRAIN WAVES WITH REFERENCE BRAIN WAVES AND CONTROL ANIMATION, DIRECTION AND VELOCITY OF GAME
44
ANIMATE PICTURES OF GAME
46
No
TERMINATION OF GAME?
48
Yes
STORE USER INFORMATION
50
END

FIG.5



# INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR00/00075

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC7 A63F 9/00**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimun documentation searched (classification system followed by classification symbols)

IPC7 A63F, A61B

Documentation searched other than minimun documentation to the extent that such documents are included in the fileds searched

JP, KR IPC as above

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search trerms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 16 MAY 2000 (16.05.2000) | 18 MAY 2000 (18.05.2000) |


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Authorized officer
MIN, Dong Sik
Telephone No. 82-42-481-5619

**DERWENT-ACC-NO:** 2000-677458

**DERWENT-WEEK:** 200233



**TITLE:** Game device using brain waves, has computer that compares, analyzes, and processes measured brain waves with respect to reference brain waves and outputs stored game program according to processed result

**INVENTOR:** CHO H S; KANG H J ; KIM H S ; PARK B W ; PARK P W

**PATENT-ASSIGNEE:** CHANGSE CO LTD[CHANN] , CHANGSE JH [CHANN] , CHANGSEI JH[CHANN] , KOREA RES INST JUNGSHIN SCI[KOREN]

**PRIORITY-DATA:** 1999KR-030201 (July 24, 1999)

**PATENT-FAMILY:**

| PUB-NO | PUB-DATE | LANGUAGE |
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| WO 0107128 A1 | February 1, 2001 | EN |
| KR 306295 B | September 24, 2001 | KO |

**DESIGNATED-STATES:** AE AL AM AT AU AZ BA BB BG BR BY CA CH CN CR CU CZ DE DK DM EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ U A UG US UZ VN YU ZA ZW AT BE CH CY DE DK EA ES FI FR GB GH GM GR IE IT KE LS LU MC MW NL OA PT SD SE SL SZ TZ UG ZW

**APPLICATION-DATA:**

| PUB-NO | APPL-DESCRIPTOR | APPL-NO | APPL-DATE |
|---|---|---|---|
| KR2000006630A | N/A | 1999KR-030201 | July 24, 1999 |
| KR 306295B | N/A | 1999KR-030201 | July 24, 1999 |
| AU 200024636A | N/A | 2000AU-024636 | January 29, 2000 |
| WO2001007128A1 | Based on | 2000WO-KR00075 | January 29, 2000 |

**INT-CL-CURRENT:**

| TYPE | IPC DATE |
|---|---|
| CIPS | A63F9/24 20060101 |

**ABSTRACTED-PUB-NO:** WO 0107128 A1

**BASIC-ABSTRACT:**

NOVELTY - The game device includes a head band (1) containing electrodes for measuring brain waves. The minute analog voltage signal of the measured brain waves is amplified and converted into a computer-

readable digital signal by a converter (2). A computer (3) processes the input brain waves signal and displays it on a display device (4).

DESCRIPTION - The computer compares, analyzes, and processes the measured brain waves with respect to reference brain waves and drives and outputs a stored game program according to the processed result. An INDEPENDENT CLAIM is also included for a gaming method for a game device.

USE - For measuring change in brain waves varying according to consciousness and will of user while reflecting individually intrinsic features of brain waves of a game and alters game situation.

ADVANTAGE - Provides game device using brain waves which vary according to change in user's will to enjoy, in which reference brain waves reflecting individual features of brain waves of each user on a real-time basis are used. Game can be controlled into a situation advantageous for user to obtain high scores, which gives an effect of being more stable mentally while enjoying the game.

DESCRIPTION OF DRAWING(S) - The figure shows a use-state schematic diagram of the game device.

Head band (1)

Converter (2)

Computer (3)

Display device (4)

**CHOSEN-DRAWING:** Dwg.1/5

**TITLE-TERMS:** GAME DEVICE BRAIN WAVE COMPUTER COMPARE PROCESS MEASURE RESPECT REFERENCE OUTPUT STORAGE PROGRAM ACCORD RESULT

**DERWENT-CLASS:** P36 T01 W04

**EPI-CODES:** T01-C10; T01-P02; W04-X02;

**SECONDARY-ACC-NO:**

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